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A New China Shock? The Untold Story of China's R&D Subsidies

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Executive Summary

China has set itself some very ambitious goals. It aims to become the world's leading nation in science and technology (S&T) before 2050. According to the 14th five-year plan, China's gross expenditures on research and development (R&D) are targeted to grow by more than 7% annually between 2021 and 2025, further increasing the current R&D-to-GDP ratio of about 2.23%. State-owned enterprises (SOEs) are likely to once again play a more prominent role in the innovation system. Importantly, they can lead state-funded research alliances with, say, small and medium-sized enterprises (SMEs) and research institutions, reflecting the government's desire for both economic outcomes and political control. Serving the vision of national self-reliance, such research alliances can alleviate some of the severe scientific and technological bottlenecks that have become evident in recent years.

China's ambitious goals have been accompanied by government policies, including R&D subsidies. Since around the turn of the millennium, the share of business R&D expenditures financed by the government has been only 4.3%, significantly lower than the OECD's average of 6.7%. However, the separation of government and private sources of funding is less clear-cut in the Chinese economy, as about half of the funds for business R&D come from non-private firms. But the steady increase in the government budget for R&D policy is accompanied by an evident lack of coordination and transparency in allocation and subsequent monitoring. This can easily lead to excesses, double funding, and the exploitation of loopholes. We calculate that between 2001 and 2011, the period in which China initiated its industrial and innovation policy, about 42% of grantees misappropriated funds – corresponding to 53% of the total R&D subsidies. Such moral hazard behavior constitutes a decisive constraint for successful policy implementation and hence for transforming well-intentioned policy designs into desirable economic outcomes.

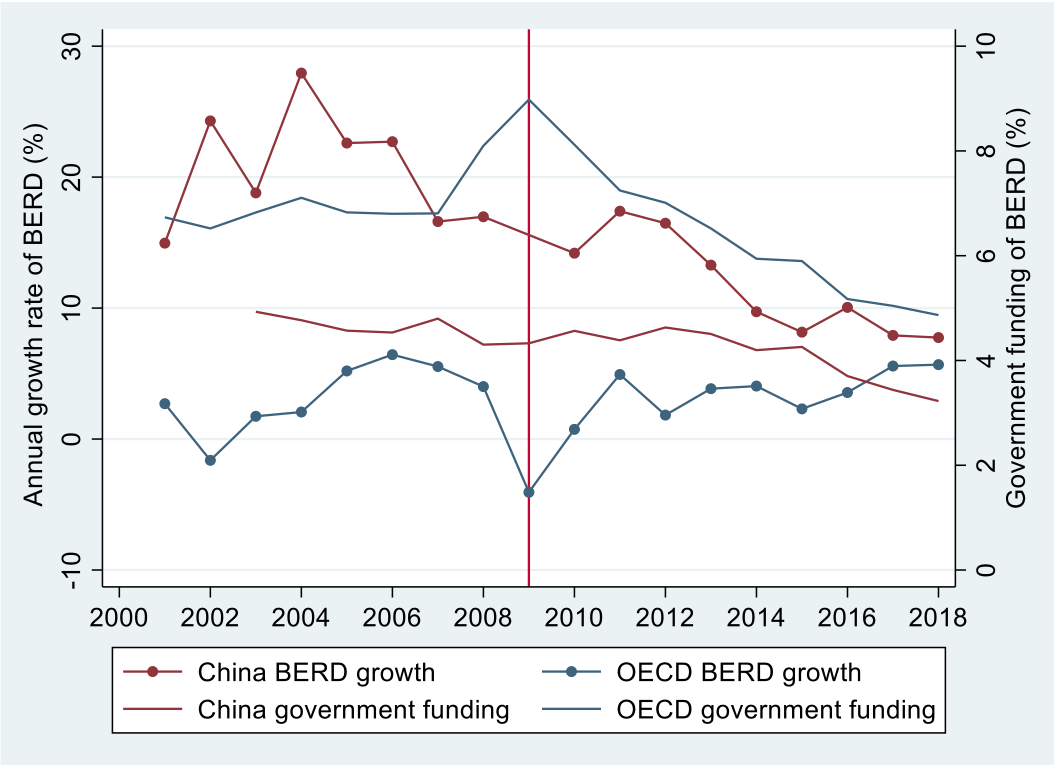
So how effective have China's R&D subsidies been in increasing Chinese firms' R&D expenditures and subsequently firm performance? We find that the policy design would have been effective without misappropriation and would have stimulated firm's total R&D expenditures by more than the assigned R&D subsidy (an outcome known as "additionality"). We also find, however, that China has lost more than half of the potential effectiveness of its R&D policy due to misappropriation. As a result, total R&D expenditures increased by far less than the R&D subsidy (an outcome known as "crowding out"). This ineffectiveness has been partially addressed through improved monitoring after 2006, but it remains insufficient. Further, we detect that the allocation of smaller/fewer subsidies is associated with higher policy impact, whereas the support of SOEs fails to induce any increase in R&D expenditures. We also identify positive effects of R&D policy on employment, investment in physical capital, sales, and patenting among grantees, although misappropriation also reduces the effectiveness of R&D policy on firm performance. By contrast, even in the absence of misappropriation, R&D policy has no impact on grantees' productivity, IT orientation of high-tech patenting, university-industry collaborations, or employment of foreign inventors.

From an international perspective, foreign businesses and governments should be concerned about the misuse of R&D subsidies for areas unrelated to the official funding purpose. Importantly, we find that some part of misused R&D subsidies is going into physical assets. Undetected misappropriation may allow Chinese firms to cross-subsidize non-research activities below the radar of (foreign) competition regulators, increasing the likelihood of unfair competition at home and abroad. Preventing the misuse of R&D subsidies not only supports fair competition; it is also in the interest of Chinese policymakers to unleash the full efficacy of their R&D policy. If China's most recent plans can indeed increase the policy's "bang for the buck," Chinese firms will emerge as increasingly innovative competitors, and foreign firms are likely to perceive China as a more attractive location for global R&D operations.

1. Introduction

China's 14th five-year plan (FYP), for the 2021–2025 period, indicates that the country's innovation capacity has, so far, been insufficient. Nonetheless, research and development (R&D) and innovation are supposed to become the main drivers of China's future productivity gains and economic growth. In terms of gross expenditures on R&D (GERD), China accounted for 24.4% of global outlays in 2018 – while the U.S., the world leader, accounted for only slightly more at 25.6% (OECD 2021). Over the past two decades, business expenditures on R&D (BERD) have been the main driver of China's R&D growth. The annual growth rate of China's BERD has consistently outpaced average growth in OECD countries (Figure 1). However, the Chinese State Council wants the country to achieve even greater innovation capacity and world leadership in S&T by 2050. This ambitious target is supported by a variety of policies, first and foremost R&D subsidies from the government. But somewhat surprisingly, between 2003 and 2018 government funding of BERD officially accounted for only 4.3% in China, significantly less than the OECD's average of 6.7%. Even in 2018, the most recent year for comparison, China's share of government-funded BERD remained 1.7 percentage points below the average ratio in the OECD.

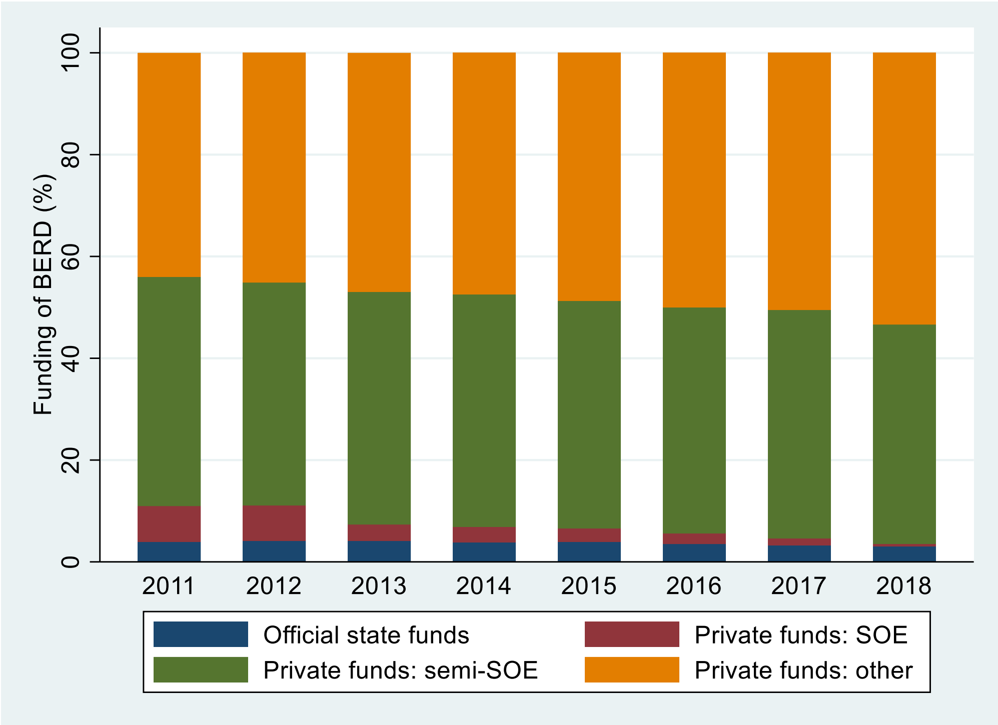
Figure 1: Business expenditures on R&D (BERD) in China and the OECD



Annual growth of BERD and state funding of BERD according to OECD data. The red line marks the year of the global financial crisis.

At the same time, the separation of government and private sources of funding is less clear-cut in the Chinese economy, where about half of the funds for business R&D come from non-private firms. Between 2011 and 2018, government funding of BERD officially accounted for 3.7% on average (Figure 2). This lower bound almost doubles to 7.1% once R&D funding through state-owned enterprises (SOEs) is added. However, Figure 2 also emphasizes the declining relative importance of SOEs in recent years. Finally, an upper bound of 51.7% is reached when self-raised R&D funds by semi-SOEs are added (for a definition of firm types see caption of Figure 2).[1] The enormous spread between the two bounds is particular to China, where state-affiliated enterprises are considerably more involved in the economy than in OECD countries. For the same reason, these figures are hardly comparable with other countries. Rather, they provide an alternative perspective on the potential for government influence in financing China's BERD.

Figure 2: Funding of business expenditures for R&D (BERD) in China



Funding of business expenditures on R&D (BERD) according to data from China's National Bureau of Statistics (measured for enterprises with industrial production activities and annual revenues ≥ of RMB 20 million). *Official state funds* include government R&D funding in all firms. *Private funds in SOEs* include self-raised funds, foreign funds, and other funds. *Private funds in semi-SOEs* include self-raised funds for R&D. Semi-SOEs are collectively-owned enterprises, cooperative enterprises, joint ownership enterprises, limited liability corporations, and share-holding corporations. *Other private funds* include foreign funds and other funds of semi-SOEs as well as self-raised funds, foreign funds, and other funds in (i) privately-owned enterprises, (ii) enterprises from Hong Kong, Macau, and Taiwan, and (iii) foreign enterprises.

The relevance of SOEs is likely to increase in the future. The 14th FYP aims to *"ensure that the annual growth rate of R&D expenditure of central state-owned industrial enterprises significantly exceeds the national average."*[2] Over the next five years China's gross expenditures on R&D are targeted to grow by more than 7% annually and to further increase China's current R&D-to-GDP ratio of about 2.23% – implying a projected growth rate for GDP below 7% (see Special Column 1, 14th FYP).[3] While foreign businesses and governments are typically concerned that China's R&D policy provides (unfair) advantages to Chinese firms in domestic and overseas markets, the Chinese government is concerned with the "bang for the buck" of its enormous policy efforts.

[1] A more precise estimate requires exact knowledge of the ultimate state-ownership in non-private firms. Given that semi-SOEs are not fully state-owned, our estimate presents an upper bound.

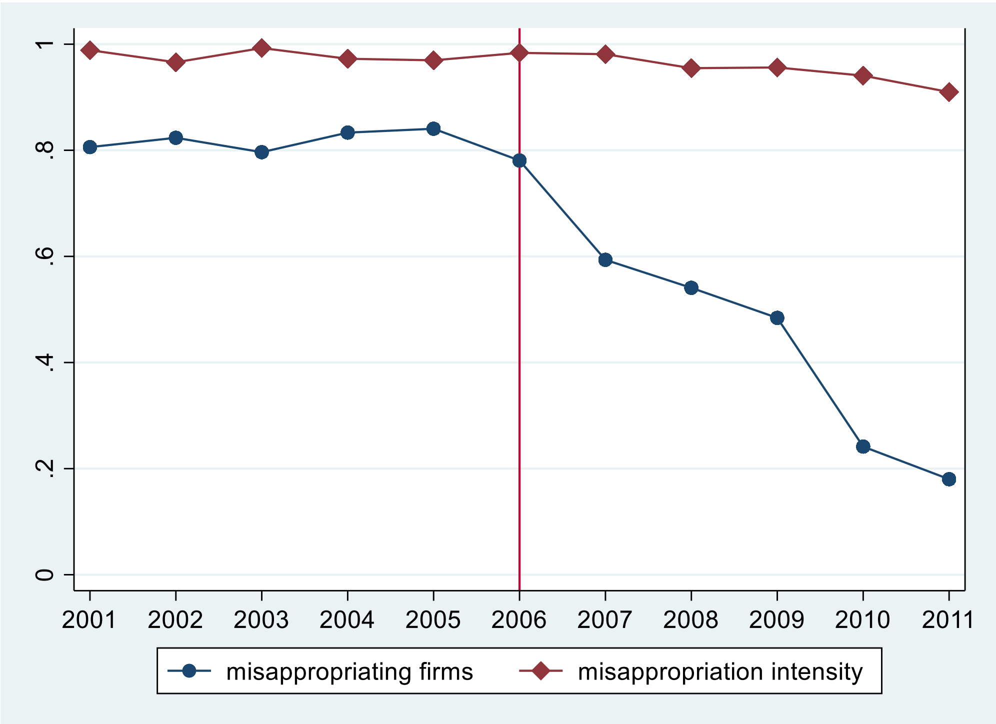
[2] See Chapter 5, Section 1, 14th FYP.

[3] The required increase in R&D inputs critically depends on China's research productivity, which has substantially declined over the past two decades (Boeing and Hünermund, 2020).

Misappropriation of R&D Subsidies: A Bigger Problem?

Given China's situation, the key question for an evidence-based policy assessment is this: How effective are China's R&D subsidies in stimulating R&D expenditures and firm performance? In a new study, we address this question based on micro-data for China's listed firms.[4] Anecdotally there is reason to believe that the misappropriation of R&D subsidies is an issue within China's innovation system, but there have not been estimates as to how severe the problem is and whether it takes a toll on policy effectiveness. In line with anecdotal evidence, we calculate that between 2001 and 2011 about 42% of grantees misappropriated funds, corresponding to 53% of the total amount of R&D subsidies (see Figure 3). Three stylized facts characterize the behavior of grantees. First, firms choose either (almost) full misappropriation or no misappropriation at all, which may be rationalized by the indivisibility of R&D projects. Second, misappropriation substantially declines over time from 81% (2001) to 18% (2011), but still remains an important issue. This decline notably coincides with a seminal policy change since 2006: the introduction of the Mid- to Long-term Plan for S&T Development (2006–2020) (MLP), which also addressed deficiencies in the selection and monitoring of grantees. Third, misappropriation in firms is also determined by subsidy size, private internal funds, rate of return to R&D, expected detection probability, and sanctioning costs. Project-specific cost thresholds lead to a u-shaped relationship between R&D subsidies and the odds of misappropriation. While insufficiently small subsidies may not help a firm to reach a threshold and start the R&D project, excessively large subsidies may outdo a firm's actual R&D funding needs.

Figure 3: Misappropriation in firms along the intensive and extensive margins



Misappropriating firms and misappropriation intensity describe the share of firms having misappropriated R&D subsidies (extensive margin) and the proportion of misappropriated R&D subsidies to total R&D subsidies (intensive margin), respectively. The red line marks the year of the introduction of the MLP, a seminal change in China's innovation and industrial policy.

[4] The focus on listed firms allows us to observe detailed information for R&D subsidies and R&D expenditures. The contribution of listed firms to China's BERD is substantial and reached 85.2% of R&D outlays by large and medium-sized industrial enterprises in 2019.

Infobox 1: Measuring misappropriation

Misappropriation of R&D subsidies occurs when a firm does not (fully) spend the allocated subsidy for R&D. The difference between the optimal R&D investment level chosen by the firm and the R&D subsidy amount measures the absolute level of misappropriation. Conditional on receiving an R&D subsidy, misappropriation $\boldsymbol{M}$ occurs if the optimal investment level $\boldsymbol{rd}^*$ is lower than the R&D subsidy $\boldsymbol{s}$:

$$M_{|s>0} = \begin{cases} 0 & if \;\; rd^* \geq s \\ 1 & if \;\; rd^* < s \end{cases}$$

For our empirical analysis, we assume that firms realize their optimal R&D plans and calculate misappropriation as the difference between total R&D expenditures and R&D subsidies received as reported in financial statements.

2. Evaluating the Impact of R&D Subsidies: Effectiveness and Efficacy

Ideally, public R&D subsidies induce additional privately financed R&D expenditures, so that total R&D expenditures (public subsidies plus private R&D) increase by more than the total amount of the subsidy. In this ideal situation, public and private funds function as complements and achieve ***additionality***. However, public and private funds may also function as substitutes, so that R&D subsidies crowd out private R&D expenditures. In a ***partial crowding-out*** situation, total R&D expenditures still increase, but by less than the subsidy amount, while private R&D expenditures actually decrease. In a ***full crowding-out situation***, total R&D expenditures do not increase *at all* because public funds function as a 1:1 substitute for private R&D expenditures. If firms struggle to turn innovative ideas into actual R&D projects because of financial constraints, R&D subsidies may induce more R&D spending. For firms without financial constraints, however, R&D subsidies simply provide an opportunity to save their own funds, lowering the government's "bang for the buck". Therefore, when policymakers consider the outcomes of R&D policy it is of great importance to them whether R&D subsidies have resulted in additionality or crowding out.

Policy Evaluation: Challenging but Revealing Findings

Government agencies often find it difficult to conduct independent and objective evaluations. Causal evaluations of R&D subsidies are challenging in general, as grantees – usually more innovative firms – often outperform non-grantees even in the absence of subsidies. This difference between the treatment and control group may induce an upward bias toward the estimated effectiveness. In other words, the policy appears to be better than it actually is. In order to measure the causal impact, therefore, it is necessary to select a matched control group that is similar to the treated grantees.[5] Comparing the R&D expenditures of firms that received R&D subsidies with those of the matched control group reveals what is known as the intention to treat (ITT) effect. The ITT shows the real ***effectiveness*** of R&D subsidy policy when misappropriation occurs. However, we can also measure the ***efficacy*** of R&D subsidy policy, i.e. the optimal impact that could have been achieved without misappropriation. For this purpose, we compare only the R&D expenditures of those firms that actually spend the subsidy on R&D (compliers) with the control group. Crucially, we take into account that the decision to be compliant depends on

[5] The ideal way to measure the causal impact would be to randomly select grantees. However, randomized control experiments are hardly ever used for R&D subsidies. The matched control sample approach aims to mimic a randomized control experiment.

the expected effect of the R&D subsidy. This is known as the complier average causal effect (CACE).

Infobox 2: Comparing effectiveness and efficacy of R&D subsidies

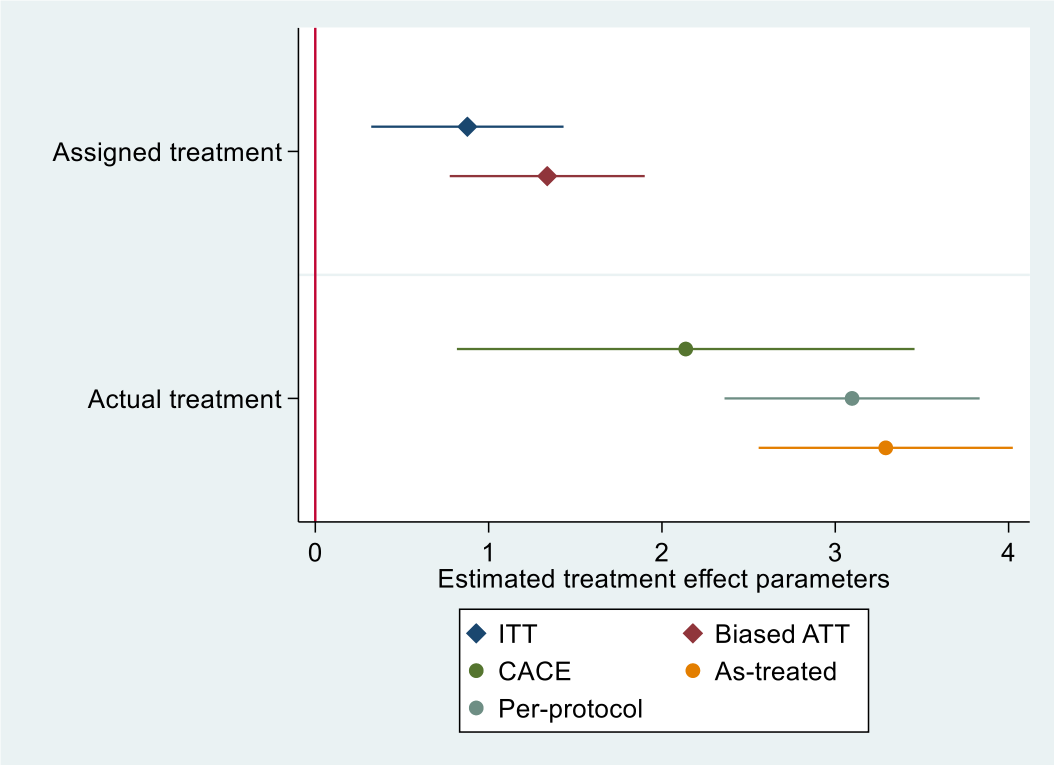
- ***Effectiveness*** shows how effective the R&D policy is in practice when misappropriation exists and is estimated by the *intention to treat (ITT) effect*
- ***Efficacy*** shows how effective the R&D policy could have been without misappropriation and is estimated by the *complier average causal effect (CACE)*
- The ratio of effectiveness to efficacy measures the loss in the effectiveness of R&D policy due to misappropriation

From a policy point of view, the ITT's effectiveness, the CACE's efficacy, and their comparison are relevant. For example, if the ITT is (close to) zero but the CACE is significantly positive, then the design of R&D programs generally works to stimulate R&D expenditures, though policymakers should still strive to improve the monitoring of grantees to reduce misuse (noncompliance). However, if both ITT and CACE are zero, then R&D policy is ineffective even in an ideal situation of full compliance due to an insufficient R&D program design. The relation of effectiveness to efficacy informs policymakers about the loss in effectiveness due to the misappropriation of R&D subsidies.

Figure 4 shows the estimated treatment effects of China's R&D subsidies. In comparison with the control group of firms that never received support (by quasi-randomized chance), compliers increased total R&D expenditures by 213.7% over a two-year period. In other words, these firms increased their R&D outlays by about 77% annually during funding. The optimal impact of R&D policy could have implied additionality, because the increase is significantly larger than the R&D subsidy amount. However, once we allow for misappropriation (noncompliance) among grantees, policy-driven growth falls to 87.7%, and private R&D outlays are crowded out by up to 25% of the assigned subsidy amount. Hence, misappropriation reduces additionality towards a partial crowding-out effect. Figure 4 also emphasizes the necessity in policy evaluations to account for endogenous R&D assignment and endogenous compliance choice to avoid an upward bias. Otherwise, both effectiveness (ITT < Biased ATT) and efficacy (CACE < Per-protocol < As-treated) are considerably overstated.[6] Strikingly, the results emphasize that more than half of China's potential policy impact is lost due to misappropriation.

[6] Biased Average Treatment Effect on the Treated (ATT) does not take into account that the allocation of R&D subsidies is non-random. Per-protocol and as-treated estimators do not take into account that firms endogenously decide whether to comply.

Figure 4: Comparison of treatment effect size for R&D subsidies



Estimated treatment effect parameters: ITT 0.877*** (0.283); Biased Average Treatment Effect on the Treated (ATT) 1.338*** (0.287); CACE 2.137*** (0.674); Per-protocol 3.097*** (0.375); As-treated 3.291*** (0.374). Rejection of full and partial crowding-out: Biased ATT***, Per-protocol***, As-treated***, CACE**. Rejection of partial crowing out >25%: ITT*. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Where Does R&D Policy Work Best?

- **Policy design and implementation.** The introduction of the MLP in 2006 marks a general change in China's industrial/innovation policy and was accompanied by more targeted subsidies and an administrative setup that aims to improve the selection and monitoring of grantees. Our analysis confirms an enhanced policy impact over time. Before 2007, ITT and CACE indicate total crowding-out, confirming that both policy design and implementation rendered R&D subsidies ineffective. Since 2007, however, effectiveness and efficacy have significantly improved, leading to additionality for compliers. While the gap between effectiveness and efficacy has narrowed, the policy effect in recent years could still be more than twice as large without misappropriation. While the MLP has improved implementation issues and has increased R&D spending, it has failed to increase productivity (output per worker) through corporate innovation. The lack of productivity improvement in the short run (over 2 years) is confirmed in the long run (over 4 years), corroborating the failure of China's R&D subsidies to induce efficiency gains. This implies that R&D projects selected for government funding do contribute the same to productivity growth than R&D projects financed through the market in the comparison group.[7] Given that China's working age population (15–64 years) has been shrinking since 2016 (World Bank 2021), supplementing labor input through innovation constitutes an important long-term goal for

[7] Another view is that the increasing support of "strategic research for the nation," which often is not provided by the market, comes at the cost of inferior economic outcomes.

maintaining output growth.

- **Subsidy size.** Irrespective of misappropriation, the assignment of smaller and/or fewer subsidies is associated with both higher effectiveness and efficacy. Strikingly, we find stronger growth in R&D expenditure for firms with below-median R&D subsidies, and additionality for both ITT and CACE. That is, R&D policy would on average stimulate private R&D in an ideal situation without misappropriation, though it has already done so in the presence of misappropriation – albeit at a lower level. These results emphasize that too high R&D subsidies fully crowd out private R&D expenditures even among compliers. We also observe the *number* of annual R&D subsidy payments between 2007 and 2011. Of all grantees, 57.3% received a single payment and 42.7% received multiple payments (up to 35) per year, with an overall average of 2.2 payments. For single-payment firms, both ITT and CACE confirm additionality, whereas we find medium-level partial crowding-out for both the ITT and CACE of multi-payment firms. These findings are at odds with the position of the Director of Guangzhou's S&T Bureau, who in 2014 stated that "in the research system, the problem certainly is not the allocation of too much funds but the misappropriation of funds" (Xinhua 2014). Our evidence shows that payments that are too large or numerous *as well as* the misappropriation of funds are problems.
- **High-tech industries.** We also compare the impact of R&D subsidies on firms in high-tech vs. low- and medium-tech industries. The majority of high-tech firms already conduct R&D before receiving a subsidy, are more likely to receive subsidies, and show a higher compliance rate compared with low- and medium-tech firms. The higher support rate in high-tech industries reflects China's picking-the-winner strategy in R&D policy, and the higher compliance rate suggests higher returns from R&D investment. Surprisingly, however, R&D subsidies do not stimulate total R&D spending in high-tech industries. Conversely, in low- and medium-tech industries R&D subsidies increase total R&D expenditure, and we find additionality for compliers. The crowding-out effect in high-tech industries may be explained by the higher prevalence of firms engaged in "processing trade," which rather assemble high-tech products but are less encouraged by the subsidy to perform R&D themselves. The effect may also indicate that high-tech firms in China are not subject to any financing restrictions before subsidy allocation. In low- and medium-tech industries, the inducement effect may be stronger because of a more grant-dependent R&D choice. Clearly, a more selective support of high-tech firms subject to financial constraints should be accompanied by stronger support of low- and medium-tech firms with unsaturated R&D potential.
- **Ownership.** SOEs are not only less likely to receive R&D subsidies, but – strikingly – they are also less compliant. Before receiving support, R&D activities take place less frequently and at a lower level. However, the support of SOEs does not increase total R&D expenditures – confirming the well-known lack of financial constraints, or creative ideas, in these firms. By contrast, China's financial system tends to discriminate private entrepreneurs. Hence, R&D subsidies provided to private firms are associated with higher effectiveness and efficacy, resulting in more R&D expenditures in general and additionality for compliers in particular. Given that the behavior of firms in the state sector has not fundamentally changed, it remains unclear whether and how a significant increase in R&D inputs of central SOEs, as called for in the 14^{th} FYP, will actually materialize and whether such an increase in inputs will lead to more innovation than achievable through the private sector.
- **Non-R&D outcomes.** We also consider policy-induced changes in firms' output and behavioral additionality. This is particularly relevant when the supply of R&D inputs is price inelastic. Here,

the policy-induced higher demand for R&D workers only increases their wages and thus the costs of inputs, but R&D policy fails to affect output or productivity. In China's case, educational reforms led to a steady increase of university graduates throughout our study period, providing a steady supply of human resources for corporate R&D. In line with this, we find positive effects on employment, output (sales), investment in physical capital, and patenting. However, as mentioned above, we find no evidence for productivity gains. We also fail to observe significant behavioral additionality with regard to IT-orientation of high-tech patenting, university-industry collaboration, or the employment of foreign inventors. For almost all indicators considered, the positive policy effects even increase in the long term, but the loss in effectiveness due to misappropriation also becomes more pronounced.

New Ideas, Old Problems: Recent Anecdotal Evidence

Our study focuses on the 2001–2011 period to rule out the possibility that our findings are biased by increasing public awareness and looming investigations that may have induced fundamental changes in firm behavior to cover up the misuse of public funds. It was not until September 2011 that public interest was sparked by media reports stating that around 60% of public research funds were misused for non-research purposes (China Youth Daily 2011). The accuracy of the figure was quickly challenged (Chinese S&T Association 2011), but subsequent investigations revealed that officials responsible for the administration of national and sub-national R&D programs, intermediaries for subsidy applications, and subsidy recipients were involved in the misuse of R&D subsidies. In 2013, S&T Minister Wan Gang described the state of research funding in China as a "malignant problem" (People's Daily 2013) and in 2014 the Central Commission for Discipline Inspection announced a new round of inspections in that area (Central Commission for Discipline Inspection 2015). In one example, fifty officials from the S&T Bureau of Guangdong Province were investigated for taking bribes from firms in exchange for R&D subsidies (Economist 2014). In Foshan, a city in Guangdong, officials and intermediaries retained 30% of the subsidies for their own purposes (Economist 2014). In 2016, the Ministry of S&T commented on the original allegations and pointed out that in recent years the use of funds had been generally in line with international practice (People's Daily 2016).

Lately, China's anti-corruption campaigns and the implementation of social credit scores[8] in the business sector suggest that monitoring through the government has been intensified up to a point where misappropriation has become irrational due to almost certain detection and sanctioning. Nonetheless, as recent as 2020 another high-profile case became public, involving the Wuhan Hongxin Semiconductor Manufacturing Co. (HSMC). HSMC received substantial investments and government support to become a "national champion" in the semiconductor industry. However, of the 15.3 billion RMB (about 1.9 billion EUR) that HSMC had received from the district government, only a little more than 10 million RMB was left when local officials announced the suspension of HSMC's operations due to funding discrepancies (36Kr 2020). Although a single case is hardly representative, it suggests that misappropriation remains a problem even in industries of utmost importance in China's efforts to achieve technological sovereignty. Such cases show that the allocation of too many subsides without sufficient monitoring remains a structural problem in China's innovation system.

Returning to our data of listed companies, 43% of firms received R&D subsidies in 2011. Although R&D subsidies are abundant in China, they accounted for only 10.8% of total subsidies between 2001 and 2011.

[8] China's social credit system monitors company behaviour across several metrics and derives benefits and sanctions.

The share of firms receiving any kind of subsidy actually increased from 31.7% in 2001 to 90.0% in 2011. The decision to grant subsidies is typically in the hands of individual government officials rather than peer reviewers and expert panels, which creates opportunities to accept bribes and extract rents from firms (Fang et al. 2018). Furthermore, in a scattered funding landscape without sufficient coordination and information exchange, it is more likely that firms seek funding for the same R&D project from different sources. In addition, firms can indicate in applications that they plan to use the grants for R&D, but in practice there is little monitoring or enforcement once they have received the funds (Cao et al. 2013). All in all, the steady increase in the government budget for R&D policy, combined with the lack of coordination and transparency in allocation and subsequent monitoring, easily leads to excess, overlap, and rent-seeking behavior (Sun and Cao 2014). In view of this likelihood, the 14th FYP emphasizes the importance of policy implementation and evaluations (Chapter 65, Section 2, 14th FYP). The allocation of subsidies that are too many or too large needs further consideration by Chinese policymakers.

3. Outlook: More Subsidies at Home – A New China Shock Abroad?

Public R&D subsidies are a means to correct the market failure of suboptimal low-knowledge production and innovation. According to our analysis, however, more than half of the total amount of R&D subsidies was misused for non-research purposes. We also show that misused funds were partially invested in physical assets – which may serve as a second-best outcome from a Chinese welfare perspective. But foreign businesses and governments should be concerned about the misuse of R&D subsidies for areas that are unrelated to the officially stated funding purpose. Undetected misappropriation may allow firms to cross-subsidize non-research activities below the radar of (foreign) competition regulators and hence increase the odds of unfair competition. Because it is difficult for foreign competition authorities to decide whether legitimately received R&D subsidies have actually been misused by Chinese firms to lower other input costs and subsequently output prices,[9] a prevention of the misuse from the outset would contribute to fair competition on international markets. It is important to emphasize that the provision of excessive R&D subsidies may also distort competition, such as when the state provides large amounts of R&D that companies would have carried out even without state support.

Beyond R&D subsidies, several other policy instruments aim to raise China's innovation capacity in the 14th FYP. First, since 2021 the R&D tax allowance rate for manufacturing firms has increased from 75% to 100%. This corresponds to a super deduction of 200% for expensed R&D expenditures, while capitalized R&D expenditures are amortized before tax at 200% of the value of the formed intangible assets (Ministry of Finance and State Administration of Taxation, 2021). According to prior research, there is a risk that firms relabel non-R&D expenses as R&D to a non-negligible extent to gain greater tax advantages.[10] Because the Chinese R&D tax system is very generous towards large firms and foreign invested enterprises (e.g. for foreign R&D centers in Shanghai, see UNCTAD announcement, 2020), the policy is likely to affect strategic business choices regarding global R&D locations (see OECD fact sheet for details on R&D tax incentives in China, 2020). Second, central SOEs are supposed to play a more prominent role in China's innovation system and may lead to state-funded research alliances with other actors, e.g. SMEs and research institutions. This will help match SOEs' financial resources with external sources of fresh

[9] The European Commission proposes to monitor the receipt of foreign subsidies (above certain thresholds) by firms from non-member states to pre-examine and prevent distortions on the internal market (European Commission, 2021). Such ex-officio reviews become more complicated when the expenditure of subsidies is not consistent with funding rules.

[10] For China's InnoCom program, Chen et al. (2021) find that many firms relabel non-R&D expenses as R&D in order to qualify for tax cuts. They estimate that almost one fourth of the reported R&D investment is due to relabelling.

ideas. Third, the formation of national alliances is designed to tackle China's major scientific and technological bottlenecks and to strengthen their technological sovereignty. This requires more uncertain basic research[11] and the funding of high-risk, high-return projects. Accordingly, in the next five years, basic research is targeted to reach 8% of China's total R&D spending, up from around 5% during the past two decades (UNESCO Institute for Statistics, 2021).[12] Fourth, though China has caught up considerably in some areas, it remains critically dependent on foreign scientific knowledge and technological equipment in others such as semiconductors. As a result, it has recently eliminated import taxes on a range of scientific, technological, and analytical equipment and publications to support the stockpiling of products without a sufficient domestic supply (Ministry of Finance, General Administration of Customs, and State Administration of Taxation, 2021). Such measures seek to support the goal of self-reliance amid growing geopolitical uncertainty, potential decoupling, and other disruptions in global supply chains. Fifth, and finally, Hong Kong's integration into the mainland's innovation system may increase international research linkages as long as overseas researchers stay put. During and after the current pandemic, China's education system may find it more difficult to tap foreign knowledge and human capital than in the past.

Moonshots to the Dark Side

More broadly, it is apparent that China's government not only seeks to correct market failures, but sees itself in the role of a far-sighted planner who ensures adequate investments in R&D through incentives and guidelines while setting the technological direction. Such mission-oriented innovation policy may be justified in, say, the context of basic research for science. This research is characterised by the fact that it is not yet directed towards a specific technological application. It can eventually lead to technological innovation, but it takes time and, initially, is far away from commercialisation. So while such systems may be good at certain moonshot projects – literally: in 2019 China landed the first spacecraft, the Chang'e 4, on the dark side of the moon – it generally remains questionable why bureaucrats should be superior to managers in generating down-to-earth innovations required for boosting economy-wide productivity growth. In addition, the misappropriation of R&D subsidies is a strong indicator of government failure in attempting to correct market failure. China's innovation system has not yet proven that it is better in generating innovation and cutting-edge technology than the globally leading innovation systems in the U.S. (Boeing and Mueller 2016). China's future success hinges on the critical assumption that government-directed markets and state-controlled innovation systems are ultimately more efficient than market economies, where the government ideally refrains from selective intervention and global ideas flow freely. OECD countries should carefully consider whether their own competitive advantage actually stems from the invisible hand of the market or from increasingly visible government intervention, e.g. mission-driven innovation policies that go well beyond correcting market failure.

Recent attempts to instil more market discipline in China's state sector and more party discipline in the private sector blur the boundaries between profit-driven vs. policy-led business strategies. Eventually, this may offset current productivity gaps between both sectors, as a higher share of policy-related cost will be shouldered by the private sector. Even if the state offers more subsidies and other means to compensate firms for fulfilling national duties, an economy without excessive policy targets and government intervention can be more successful in global competition, at least in the long run. However,

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[11] The OECD Frascati Manual 2015 defines basic research as follows: "Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view."

[12] In high-income countries, basic research typically accounts for 15% to 20% of total R&D outlays.

an exclusive fixation on economic efficiency may not be fully reflective of the Marxist-Leninist orientation of the Chinese Communist Party, which is concerned not only with economic outcomes but also with gaining and maintaining control over the system itself. For example, subsidizing SOEs and high-tech enterprises can secure control in critical sectors – but the cost is inferior economic outcomes. As long as economic efficiency and political control remain substitutes in certain areas, the internal contradiction will continue to burden China's competition with OECD countries. But China's deep global economic integration may also prove useful for extending control over foreign businesses through acquisitions abroad or in exchange for access to the Chinese market. Either way, China's future economy plans to significantly increase its R&D inputs to raise the country's innovation capacity. If China succeeds in using them for research purposes and thereby boosts productivity, foreign businesses and governments would be well advised to prepare themselves for the shock of "Innovation Made in China."

References

36Kr (2021). China's "Semiconductor Theranos": HSMC, (March 4 2021).

Boeing, P., Hünermund, P. (2020). A Global Decline in Research Productivity? Evidence from China and Germany, *Economics Letters* 197, 109646.

Boeing, P., Mueller, E. (2016). Measuring Patent Quality in Cross-country Comparison, *Economics Letters* 149, 145-147.

Boeing, P., Peters, B. (2021). Misappropriation of R&D Subsidies: Estimating Treatment Effects with One-sided Noncompliance, *ZEW Discussion Paper*, No. 21-081.

Cao, C., N. Li, X. Li, Liu, L. (2013). Reforming China's S&T System, *Science* 341 (6145), 460–462.

Central Commission for Discipline Inspection (2015). Inspection Tour Points to Necessary Reform to Prevent Research Funding to Disappear in "Black Holes" (in Chinese).

Chen, Z., Liu, Z., Serrato, J. C. S., Xu, D. Y. (2021). Notching R&D Investment with Corporate Income Tax Cuts in China, *American Economic Review* 111, 2065–2100.

China Youth Daily (2011). Research Funding Gave Birth to How Many Rich Man (in Chinese), (August 31, 2011).

Chinese Science and Technology Association, Research Propaganda Department (2011). Declaration (in Chinese), (September 8, 2011).

European Commission (2021). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on foreign subsidies distorting the internal market.

Fang, L. H., Lerner, J., Wu, C., Zhang, Q. (2018). Corruption, Government Subsidies, and Innovation: Evidence from China, *NBER Working Paper* w25098, Cambridge, MA.

Ministry of Finance and State Administration of Taxation (2021). Announcement on further improving the pre-tax deduction policy for research and development expenses (in Chinese), Announcement No. 13 (2021) of the Ministry of Finance and the State Administration of Taxation.

Ministry of Finance, General Administration of Customs, and State Administration of Taxation (2021). Notice of the Ministry of Finance, the General Administration of Customs, and the State Administration of Taxation on the Tax Policy for Imports Supporting Technological Innovation during the 14th Five-Year Plan (in Chinese), Announcement No. 23 (2021) of the Ministry of Finance, the General Administration of Customs, and the State Administration of Taxation.

OECD (2015). Frascati Manual 2015, Guidelines for Collecting and Reporting Data on Research and Experimental Development.

OECD (2021). R&D Tax Incentives: China, 2020, Directorate for Science, Technology and Innovation, March 2021.

OECD (2021). Main Science and Technology Indicators.

People's Daily (2013). Scientific Research Corruption: The Ministry of Communications Misappropriated 186 Million Yuan to Pay Wage Subsidies (in Chinese), (October 14, 2013).

People's Daily (2016). Where Did the Trillions of Research Funding Go? (in Chinese), (February 15, 2016).

Sun, Y., Cao, C. (2014). Demystifying Central Government R&D Spending in China, *Science* 345 (6200), 1006–1008

The Economist (2014). R&D in China, Research and Embezzlement, (March 20, 2014).

UNCTAD, Investment Policy Hub (2020). Shanghai Introduces Support Policies to Encourage Foreign R&D Centers.

World Bank Data (2021). Population Ages 15–64, Total – China.

Xinhua (2014). Guangdong Science and Technology Corruption Case Involves over 50 People, Intermediary Responsible for Pulling Corruption (in Chinese), (April 31, 2014).

Xinhua (2021). The Fourteenth Five-Year Plan for the National Economic and Social Development of the People's Republic of China and the Outline of Long-term Goals for 2035 (in Chinese), (March 13 2021).

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